

10-24-13

65257 - R8 CAA



US EPA
Source Test Report

XTO Energy, Inc.
RBU 11-18F Facility,
Utah

September 18, 2013

Permit: N/A

Engine: Caterpillar G3516LE

SN: 4EK04571

Unit ID: #3

Prepared By:

Oasis Emission Consultants, Inc.
2730 Commercial Way
Rock Springs, WY 82901





October 24, 2013

Ms. Rykki Tepe
XTO Energy, Inc.
810 Houston Street
Fort Worth, TX 76102

Dear Ms. Tepe:

**Re: Engine Emission Testing For XTO Energy, Inc., RBU 11-18F Facility
Unit #3.**

Oasis Emission Consultants, Inc. was requested to perform an engine emission test on a Caterpillar G3516LE lean burn engine located on tribal land in Utah.

Emission Levels

The average recorded levels were found to comply with emission levels stipulated in the guidelines of the EPA Consent Decree, as shown in the attached report, and summarized below.

Emission Unit	Avg NOx	Avg CO
gr/BHP-hr	1.43	0.29
lbs/hr	3.86	0.79

Formaldehyde Levels

Test Run	HCOH (ppm)	HCOH @ 15% O2 (ppm)	HCOH @ 15 % O2 Limit
1	18.72	8.77	14
2	18.75	8.85	14
3	18.49	8.66	14
AVG	18.65	8.76	14

Catalyst Parameters

Test Run	Inlet Temp (°F)	DP (in H2O)
1	840	6.1
2	843	6.1
3	844	6.1
AVG	842	6.1

Engine Load

Test Run	BHP
1	1222.5
2	1222.4
3	1222.4

Testing Protocol

The attached report was generated using an extractive FTIR system using methodologies as required by ASTM D6348 – 03 and/or EPA 40 CFR 63(A) Method 320.

Quality Assurance

Oasis has performed a full cursory review of the raw data and calculated results in this report. Any errors we have encountered have been listed in the body of this report. After performing the review, we are confident that this engine has met the requirements of the Consent Decree.

If you have any questions or require further information, please contact the undersigned at (307) 382-3297.

Yours truly,
Oasis Emission Consultants, Inc.



Christopher N. Knott, P.Eng.
Director, Engineering & Operations

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SOURCE EMISSION TEST REPORT

PERMIT N/A

Test Performed By: Oasis Emission Consultants, Inc.

Facility Name: RBU 11-18F Facility
 Unit #3

Emission Source: Caterpillar G3516LE

Date of Test: September 18, 2013

Date of Report: October 24, 2013

1.1 Introduction

The purpose of this source test was to demonstrate that source emissions from a Caterpillar G3516LE engine do not exceed maximum allowable levels specified by guidelines issued in EPA's Consent Decree.

The Caterpillar G3516LE engine is a lean burn engine that employs an Oxidation Catalytic Convertor to regulate emission levels.

Three test runs were performed on September 18, 2013 to analyze NOx, CO & HCOH emission levels according to methodologies outlined in the ASTM D 6348-03 & EPA 40 CFR 63(A), Method 320 Protocol. Effluent exhaust was sampled from the engine through an extractive heated stainless steel sample line interconnected to an MKS 2030 FTIR analyzer.

Each of the three runs consisted of sixty (60) readings taken at one (1) minute intervals.

Test runs were observed by the following individuals:

- Jeff Arsenault, Oasis Emission Consultants, Inc.
- Derrick, XTO Energy, Inc.

2.1 Equipment Utilization

The following equipment was used during the tests performed at this facility in conjunction with procedures outlined by ASTM D 6348-03 & EPA 40 CFR 63(A), Method 320.

- (1) MKS MultiGas 2030 FTIR Continuous Gas Analyzer
- (1) Laptop Computer For The FTIR Analyzer Using MKS MG2000 Software
- (1) 30ft or 100ft Heated Teflon Line w/ Heated Sample Probe & Spike Bypass Line
- (1) Fyrite O₂/CO₂ Analyzer
- (6) EPA Protocol G1 Calibration Gas (CO, NOx, C₂H₄, CH₃CHO, C₃H₈ & NO₂)

The MKS Multigas 2030 FTIR Analyzer was used to measure NOx & CO on a dry basis. Formaldehyde levels were measured on a wet basis and were corrected to produce levels on a dry basis. A pre Direct and System calibration measurement was made on compounds of NOx, CO, CH₃CHO, C₃H₈ & C₂H₄. In addition, a post Direct calibration was made on compounds of NOx, CO, CH₃CHO & C₃H₈. A post System calibration was also conducted for C₂H₄. Compounds of CO₂, CO, NO, CH₃CHO & C₃H₈ were measured for the quality assurance spiking requirements of ASTM D 6348-03 & EPA 40 CFR 63(A), Method 320

When a gas sample is introduced in the gas cell, the infrared beam is partially absorbed by the gas species present. The spectral frequencies absorbed and their intensity are due to the atoms associated with the chemical bond and the strength of that bond. The absorption spectrum is unique for each infrared-active gas. The MKS Analyzer measures the absorption spectrum, and its analysis algorithm measures the concentration of each gas using pre-loaded calibrations. The MG2000 software allows for the continuous measurement, display and recording of the sample stream.

The MKS Multigas 2030 FTIR Analyzer operated with a spectral resolution of 0.5 cm⁻¹ and a scan time of 30 seconds. The FTIR spectrometer utilizes a multi-pass gas cell with a 5.11 meter effective pathlength.

3.1 Discussion Of NOx, CO & HCOH Test Results

Please refer to Appendix A for the raw NOx, CO & HCOH test results. Please refer to Appendix B for a listing of all raw data, calibration error response and calculations performed per ASTM & EPA requirements. Overall the average emission levels complied with Consent Decree guidelines on a gr/BHp-hr basis. Testing for NOx, CO & HCOH were run concurrently with one another.

3.1.1 Source Test 1: Caterpillar G3516LE, NOx, CO & HCOH

The first test was performed from 14:16 to 15:15 for NOx, CO & HCOH.

The average NOx and CO levels were found to be **1.47 gr/BHP-hr and 0.29 gr/BHP-hr** respectively. The Formaldehyde level was found to be **8.77 ppm @ 15% O₂**, which tested in compliance with the current EPA standards.

Test Run	NOx (ppm)	NOx (gr/BHP-hr)	CO (ppm)	CO (gr/BHP-hr)	HCOH (ppm)	HCOH @ 15% O ₂ (ppm)
1	199.79	1.47	64.99	0.29	18.72	8.77

3.1.2 Source Test 2: Caterpillar G3516LE, NOx, CO & HCOH

The second test was performed from 15:21 to 16:20 for NOx, CO & HCOH.

The average NOx and CO levels were found to be **1.48 gr/BHP-hr and 0.29 gr/BHP-hr** respectively. The Formaldehyde level was found to be **8.85 ppm @ 15% O₂**, which tested in compliance with the current EPA standards.

Test Run	NOx (ppm)	NOx (gr/BHP-hr)	CO (ppm)	CO (gr/BHP-hr)	HCOH (ppm)	HCOH @ 15% O ₂ (ppm)
2	200.42	1.48	64.95	0.29	18.75	8.85

3.1.3 Source Test 3: Caterpillar G3516LE, NOx, CO & HCOH

The third test was performed from 16:34 to 17:33 for NOx, CO & HCOH.

The average NOx and CO levels were found to be **1.36 gr/BHP-hr and 0.29 gr/BHP-hr** respectively. The Formaldehyde level was found to be **8.66 ppm @ 15% O₂**, which tested in compliance with the current EPA standards.

Test Run	NOx (ppm)	NOx (gr/BHP-hr)	CO (ppm)	CO (gr/BHP-hr)	HCOH (ppm)	HCOH @ 15% O ₂ (ppm)
3	184.82	1.36	64.82	0.29	18.49	8.66

4.1 Stack Sampling Location

The sampling port for moisture, flow, NOx, CO and HCOH measurements was approximately 3' from the nearest upstream flow disturbance and 5' from the nearest downstream disturbance.

4.2 Stack Sampling Methods & Procedures

Testing followed EPA 40 CFR 63(A), Method 320 and/or ASTM D6348-03 methodologies per our standard protocol, with no exceptions.

5.1 Quality Assurance

CTS procedures were followed according to ASTM requirements for both pre and post testing. Similarly, QA spiking procedures were followed. Analysis of the CO₂ exhaust effluent was used to determine the dilution factor. Steady levels of the CO₂ were observed and a sufficient duration of time was allowed to elapse for a representative average.

The calibration gas was spiked into the effluent stream using a bypass line at approximately 10% of the sampling rate. The dilution factor was obtained from observation of the stack CO₂ behavior using the following equation:

$$DF = \frac{CO_2AVG - CO_2SPIKE}{CO_2AVG}$$

Where: CO₂_{AVG} = The average undiluted CO₂ stack gas concentration of spike measurements
CO₂_{SPIKE} = The average diluted CO₂ stack gas concentration when spiked

The sample recovery was then obtained from the following equation:

$$\frac{\% REC = (Spike_{MEAS} - Stack_{MEAS}) * (1 - DF)}{CS * DF}$$

Where: Spike_{MEAS} = The average diluted stack gas concentration when spiked
Stack_{MEAS} = The average undiluted stack gas concentration
DF = Dilution factor
CS = Certified concentration of calibration standards

The Sample Recovery average level for NO, CO, C₃H₈ & CH₃CHO was found to be 95.1%, 109.5%, 105.5% & 113.1% respectively, which was within the allowable tolerance of Method 320 (70% to 130%). A summary of all spiking procedures/results can be found in Appendix B.

APPENDIX A

XTO Energy, Inc.

RBU 11-18F #3

Run 1

Record	FTIR Measurements				Date	Time
	NOx Dry	CO ppm Dry	Formaldehyde 191C Wet	H2O% (High) 191C		
1	222.52979	65.572539	14.773332	12.57589	9/18/2013	14:16:20
2	219.309272	65.184803	13.943076	11.57223	9/18/2013	14:17:20
3	222.717148	65.372473	17.31056	13.382194	9/18/2013	14:18:20
4	229.989732	65.830815	15.616463	12.994609	9/18/2013	14:19:20
5	221.676646	66.175748	17.47531	14.670797	9/18/2013	14:20:20
6	218.816027	66.235123	18.381719	15.519412	9/18/2013	14:21:20
7	213.547862	65.675686	17.174324	14.101954	9/18/2013	14:22:20
8	191.715969	65.527482	15.01194	12.928119	9/18/2013	14:23:20
9	202.910625	65.948653	14.358505	12.172158	9/18/2013	14:24:20
10	201.395514	65.715499	15.583597	12.664446	9/18/2013	14:25:21
11	195.945937	65.56596	17.703656	13.729269	9/18/2013	14:26:21
12	196.532183	65.40888	15.528819	12.577708	9/18/2013	14:27:21
13	192.818291	65.411559	16.636684	13.270766	9/18/2013	14:28:21
14	184.401217	65.599343	16.960952	13.74728	9/18/2013	14:29:21
15	223.829993	65.775672	14.886176	12.413139	9/18/2013	14:30:21
16	210.1854	65.29266	14.244593	11.518035	9/18/2013	14:31:21
17	194.081867	64.87385	16.455965	12.871566	9/18/2013	14:32:21
18	177.232916	64.500506	17.586105	13.52788	9/18/2013	14:33:21
19	155.754427	64.713697	17.475617	14.136558	9/18/2013	14:34:21
20	154.401715	64.449232	16.996469	13.55336	9/18/2013	14:35:21
21	152.875736	64.378039	15.93812	13.065025	9/18/2013	14:36:22
22	172.345148	64.631942	15.091761	12.537311	9/18/2013	14:37:22
23	174.83275	64.661251	14.318074	11.654309	9/18/2013	14:38:22
24	180.674935	65.069535	14.402218	11.520315	9/18/2013	14:39:22
25	173.622754	64.874886	17.646036	12.924419	9/18/2013	14:40:22
26	183.720622	64.91803	15.135621	11.488785	9/18/2013	14:41:22
27	193.923171	64.690881	14.187588	10.911223	9/18/2013	14:42:22
28	198.456511	64.884036	17.152953	12.565259	9/18/2013	14:43:22
29	211.669076	65.409388	16.302509	12.733785	9/18/2013	14:44:22
30	224.184587	65.302416	15.599634	12.827832	9/18/2013	14:45:22
31	215.830602	65.224213	15.251177	12.607078	9/18/2013	14:46:22
32	216.451149	65.349402	16.355445	14.010116	9/18/2013	14:47:23
33	212.825517	65.14616	16.233062	13.520157	9/18/2013	14:48:23
34	214.509939	65.100798	15.335926	12.416075	9/18/2013	14:49:23
35	215.443322	64.921516	15.597556	12.926104	9/18/2013	14:50:23
36	200.999705	64.594006	15.911337	13.210808	9/18/2013	14:51:23
37	212.69187	65.086947	16.673723	13.693647	9/18/2013	14:52:23
38	207.995691	64.692649	16.08997	12.745207	9/18/2013	14:53:23
39	218.618401	64.601061	15.443316	12.334661	9/18/2013	14:54:23
40	220.753264	64.640839	16.53327	13.87127	9/18/2013	14:55:23
41	222.577601	64.938851	16.93471	14.012539	9/18/2013	14:56:23
42	214.073205	64.706225	16.338147	13.058101	9/18/2013	14:57:24
43	213.633781	64.591794	14.87262	12.296109	9/18/2013	14:58:24
44	215.916177	64.86132	14.851433	12.420948	9/18/2013	14:59:24
45	219.370031	64.987043	16.064673	13.416808	9/18/2013	15:00:24
46	198.468511	64.759736	17.88178	14.767312	9/18/2013	15:01:24
47	199.432859	65.115149	18.531694	15.256649	9/18/2013	15:02:24
48	193.213563	64.955681	18.291176	15.014096	9/18/2013	15:03:24
49	186.779515	64.735583	19.566767	15.333979	9/18/2013	15:04:24
50	198.913331	65.11396	19.772945	16.250125	9/18/2013	15:05:24
51	207.692611	65.164326	18.032382	14.947081	9/18/2013	15:06:24
52	190.855162	64.538446	16.565045	13.418738	9/18/2013	15:07:24
53	165.650755	64.200375	16.888791	13.538352	9/18/2013	15:08:25
54	179.521694	64.230527	16.818519	13.462181	9/18/2013	15:09:25
55	175.90073	64.420867	16.615272	13.299211	9/18/2013	15:10:25
56	190.708538	64.353628	16.58928	13.280759	9/18/2013	15:11:25
57	197.375338	64.31001	16.265293	13.190341	9/18/2013	15:12:25
58	196.975745	64.209547	15.612403	12.873994	9/18/2013	15:13:25
59	199.299339	64.357576	14.731172	11.966409	9/18/2013	15:14:25
60	188.79618	64.095596	14.597384	11.872512	9/18/2013	15:15:25
AVG	199.79	64.99	16.25	13.19		

Calculated Emission Levels					
NOx (gr/BHr-hr)	NOx (lbs/hr)	CO (gr/BHr-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH @ 15% O2 (ppm)
1.47	3.95	0.29	0.78	18.72	8.77

XTO Energy, Inc.

RBU 11-18F #3

Run 2

Record	FTIR Measurements				Date	Time
	NOx Dry	CO ppm Dry	Formaldehyde 191C Wet	H2O% (High) 191C		
1	216.22364	64.656252	16.143583	12.116012	9/18/2013	15:21:43
2	212.994907	64.833187	16.080654	12.812356	9/18/2013	15:22:43
3	206.302044	64.953262	16.164821	12.998882	9/18/2013	15:23:43
4	201.629097	65.055266	16.262499	13.20427	9/18/2013	15:24:43
5	194.45884	65.301658	16.358839	13.094802	9/18/2013	15:25:44
6	201.589278	65.460221	16.514646	13.106059	9/18/2013	15:26:44
7	217.836291	65.649463	16.401452	13.195124	9/18/2013	15:27:44
8	210.783431	65.65634	16.358225	13.208105	9/18/2013	15:28:44
9	224.442675	65.500438	16.233422	13.226576	9/18/2013	15:29:44
10	225.980889	65.591138	16.247922	13.218257	9/18/2013	15:30:44
11	221.884075	65.4198	16.160554	13.15597	9/18/2013	15:31:44
12	229.054455	65.616264	16.124287	13.161514	9/18/2013	15:32:45
13	231.963336	66.052429	16.072884	13.19462	9/18/2013	15:33:44
14	242.636476	66.515779	16.056299	13.162457	9/18/2013	15:34:45
15	253.449499	66.603976	15.951637	13.226358	9/18/2013	15:35:45
16	247.403975	66.231833	15.982749	13.173688	9/18/2013	15:36:45
17	235.044383	66.045533	16.091564	13.144405	9/18/2013	15:37:45
18	232.299864	65.912293	16.022553	13.132429	9/18/2013	15:38:45
19	225.176661	65.358772	16.051011	13.089068	9/18/2013	15:39:45
20	205.066583	65.067628	16.017988	12.958003	9/18/2013	15:40:45
21	208.671861	65.24738	16.28766	13.165215	9/18/2013	15:41:45
22	196.188238	64.682887	16.534669	13.245493	9/18/2013	15:42:45
23	190.070218	65.0986	16.464661	13.165062	9/18/2013	15:43:45
24	195.44259	65.055702	16.299121	13.124635	9/18/2013	15:44:46
25	183.534332	64.547623	16.306394	13.065084	9/18/2013	15:45:46
26	179.133708	64.501151	16.372747	13.23421	9/18/2013	15:46:46
27	182.578438	64.260389	16.348247	13.056987	9/18/2013	15:47:46
28	195.536957	64.309292	16.285785	13.256195	9/18/2013	15:48:46
29	195.075676	64.33436	16.271943	13.093161	9/18/2013	15:49:46
30	167.602841	63.849045	16.331404	12.969831	9/18/2013	15:50:46
31	151.199321	64.239955	16.618613	13.196826	9/18/2013	15:51:46
32	147.65433	63.915473	16.630554	12.942154	9/18/2013	15:52:46
33	153.339553	64.328744	16.621261	13.127128	9/18/2013	15:53:46
34	174.705084	64.428207	16.458704	12.967573	9/18/2013	15:54:47
35	191.726535	64.743876	16.252716	13.21382	9/18/2013	15:55:47
36	190.792479	64.120631	16.327462	12.988951	9/18/2013	15:56:47
37	193.877366	64.695623	16.308104	13.216457	9/18/2013	15:57:47
38	183.246594	64.325791	16.509536	13.121867	9/18/2013	15:58:47
39	181.960977	64.479144	16.346426	13.098413	9/18/2013	15:59:47
40	180.324814	64.847388	16.50406	13.099724	9/18/2013	16:00:47
41	200.291643	65.197936	16.379744	13.084884	9/18/2013	16:01:47
42	195.755152	64.916892	16.349807	13.103444	9/18/2013	16:02:47
43	197.600326	64.816439	16.344509	13.13613	9/18/2013	16:03:47
44	216.867958	65.271051	16.28907	13.165909	9/18/2013	16:04:48
45	231.347592	65.534188	16.188107	13.180732	9/18/2013	16:05:48
46	238.738649	65.374147	16.017672	13.164992	9/18/2013	16:06:48
47	246.388202	65.44775	15.900771	13.137008	9/18/2013	16:07:48
48	229.983	65.134121	16.054278	13.135858	9/18/2013	16:08:48
49	215.089155	65.067455	16.180845	13.103879	9/18/2013	16:09:48
50	214.341652	64.850232	16.144804	13.108976	9/18/2013	16:10:48
51	196.134768	64.653451	16.154014	13.008518	9/18/2013	16:11:48
52	185.293116	64.509212	15.683581	12.617327	9/18/2013	16:12:48
53	171.146405	64.540353	15.31311	12.313448	9/18/2013	16:13:49
54	159.042711	64.260821	15.545263	12.457418	9/18/2013	16:14:49
55	154.966471	64.623353	18.601145	14.310297	9/18/2013	16:15:49
56	172.410104	64.600979	17.559675	13.653623	9/18/2013	16:16:49
57	168.648312	64.179916	16.562083	13.107575	9/18/2013	16:17:49
58	186.672992	64.41441	16.40258	13.108339	9/18/2013	16:18:49
59	191.653	64.291164	16.265128	13.001065	9/18/2013	16:19:49
60	173.991296	63.88851	16.430562	13.075076	9/18/2013	16:20:49
AVG	200.42	64.95	16.30	13.10		

Calculated Emission Levels					
NOx (gr/Bhp-hr)	NOx (lbs/hr)	CO (gr/Bhp-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH @ 15% O2 (ppm)
1.48	3.99	0.29	0.79	18.75	8.85

XTO Energy, Inc.

RBU 11-18F #3

Run 3

Record	FTIR Measurements				Date	Time
	NOx Dry	CO ppm Dry	Formaldehyde 191C Wet	H2O% (High) 191C		
1	226.552634	66.281561	16.093372	11.951964	9/18/2013	16:34:18
2	227.45352	66.442189	15.694061	12.433265	9/18/2013	16:35:18
3	215.242177	66.226696	14.702744	11.762741	9/18/2013	16:36:18
4	205.293289	65.851412	14.776047	12.045362	9/18/2013	16:37:18
5	215.907	66.051367	14.648955	11.870648	9/18/2013	16:38:18
6	200.718698	65.634566	14.410644	11.538417	9/18/2013	16:39:18
7	208.870813	65.793295	14.431276	11.792168	9/18/2013	16:40:18
8	207.946171	65.662231	14.451605	11.683257	9/18/2013	16:41:19
9	199.74326	65.954695	16.022009	13.317684	9/18/2013	16:42:19
10	206.837186	66.335101	18.300841	15.0163	9/18/2013	16:43:19
11	223.310943	66.494622	20.375198	16.239194	9/18/2013	16:44:19
12	234.185124	66.684552	19.942214	15.185301	9/18/2013	16:45:19
13	224.465424	66.049818	16.378617	13.556968	9/18/2013	16:46:19
14	208.520506	65.595228	15.490387	12.894748	9/18/2013	16:47:19
15	201.94462	65.270486	17.495733	13.949823	9/18/2013	16:48:19
16	197.980726	65.270814	16.39267	13.223583	9/18/2013	16:49:19
17	187.728547	65.127765	16.367575	12.990125	9/18/2013	16:50:20
18	189.846742	65.110264	15.739492	12.781247	9/18/2013	16:51:20
19	186.931951	64.901126	17.408288	13.675852	9/18/2013	16:52:20
20	197.453858	64.960185	16.475941	13.122373	9/18/2013	16:53:20
21	208.771158	65.243269	15.655627	12.810373	9/18/2013	16:54:20
22	191.1687	64.660017	14.792149	12.01754	9/18/2013	16:55:20
23	168.372989	64.67774	15.712923	12.753579	9/18/2013	16:56:20
24	159.563876	64.696779	18.535593	14.390819	9/18/2013	16:57:20
25	159.978578	64.209068	17.441063	13.506899	9/18/2013	16:58:20
26	156.128578	64.198103	15.859149	12.721985	9/18/2013	16:59:21
27	167.615284	64.63014	15.633604	12.556758	9/18/2013	17:00:21
28	165.032431	64.462204	16.733194	13.246621	9/18/2013	17:01:21
29	192.61116	64.655379	17.755571	13.844352	9/18/2013	17:02:21
30	215.718045	65.015536	16.208476	13.209812	9/18/2013	17:03:21
31	218.428587	65.103445	16.071947	13.110678	9/18/2013	17:04:21
32	205.099696	64.692058	15.14236	12.428479	9/18/2013	17:05:21
33	174.398801	64.021228	14.492215	11.601666	9/18/2013	17:06:21
34	149.891105	63.796208	14.57397	11.42501	9/18/2013	17:07:21
35	146.155176	64.044873	14.576664	11.602211	9/18/2013	17:08:22
36	157.222823	64.328846	17.121681	13.387681	9/18/2013	17:09:22
37	163.668068	63.962738	18.288191	14.873413	9/18/2013	17:10:22
38	174.802817	64.077177	17.503228	13.832296	9/18/2013	17:11:22
39	173.614462	63.722722	18.941704	14.403413	9/18/2013	17:12:22
40	168.954723	63.529588	17.627482	13.743647	9/18/2013	17:13:22
41	177.404894	63.412525	16.507836	13.230596	9/18/2013	17:14:22
42	179.96388	63.494543	16.449996	13.095851	9/18/2013	17:15:22
43	177.244723	63.505327	16.464364	13.05333	9/18/2013	17:16:22
44	172.195963	63.715847	16.513393	13.202774	9/18/2013	17:17:22
45	169.559721	63.686085	16.603465	12.993063	9/18/2013	17:18:23
46	172.352198	63.935301	16.545002	13.168031	9/18/2013	17:19:23
47	168.966583	64.080963	16.498358	12.971934	9/18/2013	17:20:23
48	154.996925	63.808756	15.48271	12.239816	9/18/2013	17:21:23
49	152.549941	64.093852	14.903751	11.645984	9/18/2013	17:22:23
50	143.854827	64.23158	14.420196	10.951766	9/18/2013	17:23:23
51	135.604218	64.399374	14.050044	10.71962	9/18/2013	17:24:23
52	139.76763	64.292621	14.257704	11.050411	9/18/2013	17:25:23
53	153.658062	64.497451	14.938314	11.984185	9/18/2013	17:26:23
54	169.665597	64.729738	16.036097	13.145059	9/18/2013	17:27:24
55	176.928988	64.900873	15.836926	12.96403	9/18/2013	17:28:24
56	195.251463	65.236044	15.020286	12.027404	9/18/2013	17:29:24
57	186.002939	64.857794	14.90508	11.755282	9/18/2013	17:30:24
58	184.263163	64.690175	14.454263	11.400866	9/18/2013	17:31:24
59	192.794749	65.015674	16.178973	13.001845	9/18/2013	17:32:24
60	201.80438	65.098553	16.38907	13.876238	9/18/2013	17:33:24
AVG	184.82	64.82	16.11	12.85		

Calculated Emission Levels					
NOx (gr/BHp-hr)	NOx (lbs/hr)	CO (gr/BHp-hr)	CO (lbs/hr)	HCOH Dry (ppm)	HCOH @ 15% O2 (ppm)
1.36	3.65	0.29	0.78	18.49	8.66

APPENDIX B

Raw Calibration Data

BACKGROUND

Date	Time	NO 191C span	NO2 191C span	H2O% (high) 191C	Formaldehyde 191C	Ethylene 191C TE span	Propane 191C span	Acetaldehyde 191C span	CO ppm 191C (1of2) span	CO ppm Dry	CO2% 191C	NOx Wet	NOx Dry	NM NE HC C3
9/18/2013	13:30:20	0.282483	-0.013283	-0.000525	-0.123455	0.586359	-0.843112	1.90806	0.221663	0.211862	0.022158	0.2892	0.269199	0.116691
9/18/2013	13:30:28	0.139518	0.097237	0.000141	-0.089096	0.044372	-0.084567	0.802294	0.083282	0.083262	0.019656	0.236755	0.236755	0.078797
9/18/2013	13:31:35	0	0	0	0	0	0	0	0	0	0	0	0	0
9/18/2013	13:31:48	-0.244547	0.025048	-0.001181	-0.029181	-0.175088	0.368915	-0.335925	0.087353	0.087352	0.005718	-0.219501	-0.219498	0.065196
9/18/2013	13:31:56	0.093144	0.096934	0.002571	-0.025009	-0.184934	-0.080524	0.21385	0.079084	0.071386	0.007341	0.078084	0.078084	0.078084
9/18/2013	13:32:03	-0.052893	0.025271	0.000295	-0.029777	0.802039	-0.133272	0.72939	-0.017197	0.007191	-0.000262	0.021327	0.021327	0.021327
9/18/2013	13:32:11	-0.052898	0.033518	-0.00473	0.027398	-0.594894	-0.49447	0.481626	0.089093	0.089093	0.007948	-0.016378	-0.016377	0.486161
9/18/2013	13:32:18	-0.052925	-0.045308	-0.00828	0.004885	-0.584268	-0.463821	0.375171	-0.137803	-0.137803	0.000753	-0.138249	-0.138249	0.029588
9/18/2013	13:32:26	-0.065894	0.049356	-0.009074	-0.048296	0.52885	-0.499732	0.417817	0.096061	0.096060	-0.0097	-0.016538	-0.016537	0.042564
9/18/2013	13:32:33	-0.222022	-0.011328	0.000293	0.055837	0.009248	-0.538767	-0.532582	0.080556	0.080556	-0.003839	-0.233351	-0.233351	0.000000
9/18/2013	13:32:41	-0.031024	0.100416	-0.004801	-0.023222	-0.79873	0.100677	0.253511	-0.240506	-0.240506	0.005701	0.069392	0.069392	0.003787
9/18/2013	13:32:49	-0.040791	-0.008353	-0.003333	-0.032587	-0.620612	0.332965	-0.212831	-0.248669	-0.248669	-0.008625	-0.049142	-0.049142	0.014528
9/18/2013	13:32:56	-0.026497	0.014527	-0.007822	0.084765	-0.63024	-0.585394	-0.234492	-0.072484	-0.072484	-0.005997	-0.01197	-0.01197	0.032408

PRE DIRECT CAL

Date	Time	CO ppm 191C (1of2) span	NOx Wet	Propane 191C span	Date	Time	Ethylene 191C TE	Date	Time	Acetaldehyde 191C span	
9/18/2013	13:33:04	2.169103	2.168447	2.677933	9/18/2013	13:37:57	0.009689	9/18/2013	13:35:02	-0.289209	
9/18/2013	13:33:11	111.080668	112.228399	110.150352	9/18/2013	13:38:04	0.598142	9/18/2013	13:35:10	1.279581	
9/18/2013	13:33:19	324.701404	323.519079	320.285935	9/18/2013	13:38:12	0.405843	9/18/2013	13:35:17	19.958519	
9/18/2013	13:33:26	446.848037	447.252188	443.715824	9/18/2013	13:38:19	22.17154	9/18/2013	13:35:25	23.689882	
9/18/2013	13:33:34	486.342652	487.528427	483.899001	9/18/2013	13:38:27	73.62688	9/18/2013	13:35:32	25.549749	
9/18/2013	13:33:41	497.143164	498.891928	495.041224	9/18/2013	13:38:34	92.547058	9/18/2013	13:35:39	24.746072	
9/18/2013	13:33:49	501.814851	503.806954	498.694132	9/18/2013	13:38:42	98.386143	9/18/2013	13:35:47	25.509	
									9/18/2013	13:35:55	25.087319
									9/18/2013	13:36:03	25.326688
									9/18/2013	13:36:10	26.710882

PRE SYSTEM CAL

Date	Time	CO ppm 191C (1of2) span	NOx Wet	Propane 191C span	Date	Time	Ethylene 191C TE	Date	Time	Acetaldehyde 191C span	
9/18/2013	13:44:27	51.503252	255.185575	12.541523	9/18/2013	13:54:34	9.552171	9/18/2013	13:48:56	-1.221626	
9/18/2013	13:44:34	73.762442	200.737877	48.134318	9/18/2013	13:54:42	38.942088	9/18/2013	13:47:04	7.186952	
9/18/2013	13:44:42	249.800334	363.716995	219.829474	9/18/2013	13:54:49	90.014214	9/18/2013	13:47:11	17.286498	
9/18/2013	13:44:49	281.889662	394.744043	252.131482	9/18/2013	13:54:57	97.962355	9/18/2013	13:47:19	19.433648	
9/18/2013	13:44:57	285.455949	394.817104	257.329491	9/18/2013	13:54:57		9/18/2013	13:47:26	21.772122	
9/18/2013	13:45:04	285.126959	392.537841	258.200742	9/18/2013	13:54:57		9/18/2013	13:47:34	20.788348	
9/18/2013	13:45:12	285.126959	400.800771	259.200742	9/18/2013	13:54:57		9/18/2013	13:47:41	22.995	
9/18/2013	13:45:19	405.488548	447.205828	387.794444	9/18/2013	13:54:57		9/18/2013	13:47:49	23.239888	
9/18/2013	13:45:27	472.011936	474.277213	469.080962	9/18/2013	13:54:57		9/18/2013	13:47:56	23.843738	
9/18/2013	13:45:34	479.476326	478.649632	477.037095	9/18/2013	13:54:57		9/18/2013	13:48:04	22.099678	
9/18/2013	13:45:42	480.453485	477.990112	480.365743	9/18/2013	13:54:57		9/18/2013	13:48:11	22.005667	
9/18/2013	13:45:49	480.343433	478.035706	481.855822	9/18/2013	13:54:57		9/18/2013	13:48:19	22.875158	
9/18/2013	13:45:57	481.924364	479.808055	480.713061	9/18/2013	13:54:57		9/18/2013	13:48:26	22.039331	
9/18/2013	13:46:04	483.721607	481.268975	481.173743	9/18/2013	13:54:57		9/18/2013	13:48:33	22.918375	
9/18/2013	13:46:12	483.969549	482.019263	486.844448	9/18/2013	13:54:57		9/18/2013	13:48:41	22.850904	
9/18/2013	13:46:19	483.969549	482.019263	486.844448	9/18/2013	13:54:57		9/18/2013	13:48:46	21.731434	
9/18/2013	13:46:27	486.496395	484.220452	487.481801	9/18/2013	13:54:57		9/18/2013	13:49:04	23.568617	
									9/18/2013	13:49:11	22.960429
									9/18/2013	13:49:19	22.702782
									9/18/2013	13:49:26	23.424127
									9/18/2013	13:49:33	22.81069
									9/18/2013	13:49:41	54.3772
									9/18/2013	13:49:49	23.464181
									9/18/2013	13:49:57	23.302839
									9/18/2013	13:50:04	23.519419
									9/18/2013	13:50:11	23.742624
									9/18/2013	13:50:19	23.40673
									9/18/2013	13:50:41	23.16411
									9/18/2013	13:50:48	22.53867
									9/18/2013	13:50:55	21.57417
									9/18/2013	13:51:03	51.984393
									9/18/2013	13:51:11	22.083857
									9/18/2013	13:51:18	21.774618
									9/18/2013	13:51:26	22.209612
									9/18/2013	13:51:33	20.773998
									9/18/2013	13:51:41	22.578238
									9/18/2013	13:51:48	22.373176
									9/18/2013	13:51:55	22.775862
									9/18/2013	13:52:03	22.74648
									9/18/2013	13:52:11	22.844701
									9/18/2013	13:52:18	22.41616
									9/18/2013	13:52:26	21.983049
									9/18/2013	13:52:33	23.302689
									9/18/2013	13:52:41	22.437984
									9/18/2013	13:52:48	22.254737
									9/18/2013	13:52:56	23.049869
									9/18/2013	13:53:04	23.399461
									9/18/2013	13:53:11	23.97475
									9/18/2013	13:53:18	22.918436
									9/18/2013	13:53:26	23.182428
									9/18/2013	13:53:33	23.999425
									9/18/2013	13:53:41	23.307393
									9/18/2013	13:53:48	22.806418
									9/18/2013	13:53:56	24.882001

NO2 CAL

Date	Time	NO2 191C span
9/18/2013	13:36:50	0.011311
9/18/2013	13:36:58	1.229724
9/18/2013	13:37:05	95.550197
9/18/2013	13:37:13	145.202195
9/18/2013	13:37:20	148.227261

SAMPLE SPIKE RECOVERY

Date	Time	CO2% 191C	CO ppm 191C (1o12) span	NO 191C span	Propane 191C span
9/18/2013	14:07:46	6.623226	57.415918	177.823001	8.114142
9/18/2013	14:07:53	6.558943	56.503637	172.76857	8.714986
9/18/2013	14:08:31	6.78455	58.595251	185.409935	7.269336
9/18/2013	14:08:38	6.785072	58.28304	183.404496	7.609935
9/18/2013	14:08:45	6.73156	58.16055	179.820338	8.160330
9/18/2013	14:08:53	2.846037	126.05902	191.55841	93.34541
9/18/2013	14:09:01	0.323364	413.230446	410.657953	405.46808
9/18/2013	14:09:08	0.090807	453.494418	449.958233	450.72153
9/18/2013	14:09:16	0.034929	460.354118	455.50053	455.830884
9/18/2013	14:09:23	2.674529	265.998409	340.178444	247.95205
9/18/2013	14:09:31	5.644838	131.907678	215.856469	90.254692
9/18/2013	14:09:38	5.974329	112.178901	189.935848	68.187942
9/18/2013	14:09:46	6.054107	109.965977	205.874019	64.774961
9/18/2013	14:09:53	6.070361	109.3137	202.874018	63.828785
9/18/2013	14:10:01	6.058152	109.389039	202.014895	64.428295
9/18/2013	14:10:08	5.982564	114.61663	213.007986	68.692003
9/18/2013	14:10:16	5.754318	128.082178	220.999119	83.695575
9/18/2013	14:10:23	5.716265	130.559292	218.884778	88.822877
9/18/2013	14:10:31	5.728401	130.585517	214.349847	87.826664
9/18/2013	14:10:38	5.801939	125.058838	210.785283	81.948628
9/18/2013	14:10:46	5.859514	120.171772	206.800324	75.337801
9/18/2013	14:10:53	5.847618	122.345288	213.800303	78.830353
9/18/2013	14:11:01	5.874976	116.151723	199.271142	73.853341
9/18/2013	14:11:08	5.71613	117.060238	195.75622	73.849869
9/18/2013	14:11:16	5.682593	119.145842	203.899692	78.70932
9/18/2013	14:11:23	5.691703	113.145862	189.398738	70.029206
9/18/2013	14:11:31	5.833362	110.632091	202.240331	67.058238
9/18/2013	14:11:38	5.893993	112.151171	204.004426	67.355808
9/18/2013	14:11:46	5.842408	112.816179	216.049487	67.712392
9/18/2013	14:12:01	5.759398	113.772525	221.787858	69.936868
9/18/2013	14:12:09	5.757956	109.927965	202.530779	67.171718
9/18/2013	14:12:16	5.688483	110.207052	188.879768	67.777103
9/18/2013	14:12:24	5.798389	109.175958	201.963115	65.249894
9/18/2013	14:12:31	5.927575	103.856932	202.577893	58.851709
9/18/2013	14:12:54	6.137009	93.511631	180.43667	47.534567

ACETALDEHYDE SPIKE RECOVERY

Date	Time	CO2% 191C	Acetaldehyde 191C span
9/18/2013	14:02:47	6.679641	1.094151
9/18/2013	14:02:55	6.638472	0.877914
9/18/2013	14:03:02	6.647797	0.769816
9/18/2013	14:03:40	6.64706	-0.74483
9/18/2013	14:03:47	6.514866	-0.42863
9/18/2013	14:03:55	6.537398	-0.93795
9/18/2013	14:04:02	6.302124	-0.537407
9/18/2013	14:04:10	1.756277	14.893483
9/18/2013	14:04:17	0.217747	20.983297
9/18/2013	14:04:25	0.055299	21.297471
9/18/2013	14:04:32	0.036458	23.26588
9/18/2013	14:04:40	3.239837	13.837695
9/18/2013	14:04:47	5.918851	4.630167
9/18/2013	14:04:55	8.220509	2.23454
9/18/2013	14:05:02	3.88979	1.784959
9/18/2013	14:05:10	6.261428	3.166145
9/18/2013	14:05:17	6.151464	2.418418
9/18/2013	14:05:25	6.124044	1.991219
9/18/2013	14:05:32	6.895856	2.750797
9/18/2013	14:05:40	6.111831	1.81049
9/18/2013	14:05:47	6.062289	1.135803
9/18/2013	14:05:55	6.037419	3.386878
9/18/2013	14:06:17	5.865502	1.834468

POST DIRECT CAL

Date	Time	CO ppm 191C (1o12) span	NOx Wet	Propane 191C span	Date	Time	Acetaldehyde 191C span
9/18/2013	17:45:34	0.142374	0.176237	0.388283	9/18/2013	17:47:21	0.562996
9/18/2013	17:45:41	0.02769	-0.181266	-0.669446	9/18/2013	17:47:28	2.632883
9/18/2013	17:45:49	-0.097563	0.119966	-0.289561	9/18/2013	17:47:38	15.991017
9/18/2013	17:45:56	-0.461837	-0.709397	5.311928	9/18/2013	17:47:44	24.277123
9/18/2013	17:46:04	129.851959	129.677587	137.3057	9/18/2013	17:47:51	26.599553
9/18/2013	17:46:11	330.532098	338.116308	325.354273	9/18/2013	17:48:11	25.3001
9/18/2013	17:46:19	451.399112	450.866118	445.62899	9/18/2013	17:48:15	25.043884
9/18/2013	17:46:27	481.523202	480.900984	487.890989	9/18/2013	17:48:26	28.934352
9/18/2013	17:46:34	501.253116	499.777179	499.392887	9/18/2013	17:48:33	25.520859

POST SYSTEM CAL

Date	Time	Ethylene 191C TE
9/18/2013	17:38:44	12.877895
9/18/2013	17:38:51	48.241953
9/18/2013	17:38:59	87.652412
9/18/2013	17:39:06	93.308833
9/18/2013	17:39:14	94.078888
9/18/2013	17:39:21	94.795126

FTIR QA/QC SUMMARY

SAMPLE RECOVERY CALCULATIONS																
Period	Spike #	Concentration of CO Cylinder	Concentration of Propane Cylinder	Concentration of NO Cylinder	Stack CO2 Concentration	Stack CO Concentration	Stack NO Concentration	Stack Propane Concentration	Stack + Spike CO2 Concentration	Stack + CO Concentration	Stack + NO Concentration	Stack + Propane Concentration	DF Calculated	% Recovery CO	% Recovery NO	% Recovery Propane
PRE TEST	1	498.8	502.0	507.0	6.6	56.5	172.8	8.7	5.9	103.7	202.6	58.9	0.096	109.5%	95.1%	105.5%

ACETALDEHYDE SAMPLE RECOVERY CALCULATIONS								
Period	Spike #	Concentration of CH3CHO Cylinder	Stack CO2 Concentration	Stack CH3CHO Concentration	Stack + Spike CO2 Concentration	Stack + CH3CHO Concentration	DF Calculated	
PRE TEST	1	26.0	6.6	0.8	6.0	3.4	0.092	113.1%

PRE SYSTEM CAL			
Sensor	System Response (ppm)	Cal Level (ppm)	Cal Recovery (%)
NOx	484.2	507.0	-4.5
CO	486.5	498.8	-2.5
Propane	487.5	502.0	-2.9
*Ethylene	98.0	99.0	-1.0
Acetaldehyde	24.9	26.0	-4.3

PRE DIRECT CAL					
Sensor	Analyzer Response (ppm)	Cal Level (ppm)	Zero Response (ppm)	Cal Error (%)	Zero Error (%)
NOx	503.8	507.0	0.4	-0.6	0.1
CO	501.8	498.8	-0.1	0.6	-0.01
Propane	498.7	502.0	0.4	-0.7	0.1
Ethylene	98.4	99.0	-0.4	-0.6	-0.4
Acetaldehyde	25.7	26.0	-0.4	-1.1	-1.6

POST DIRECT CAL					
Sensor	Analyzer Response (ppm)	Cal Level (ppm)	Zero Response (ppm)	Cal Error (%)	Zero Error (%)
NOx	499.8	507.0	0.3	-1.4	0.1
CO	501.3	498.8	0.1	0.5	0.02
Propane	500.0	502.0	0.4	-0.4	0.1
Acetaldehyde	25.5	26.0	0.4	-1.8	1.6

POST SYSTEM CAL			
Sensor	System Response (ppm)	Cal Level (ppm)	Cal Recovery (%)
*Ethylene	94.8	99.0	-4.2

*CTS Scans are conducted with Ethylene through the sample line.

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number: E05NI99E15A0000 Reference Number: 54-124366204-1
 Cylinder Number: CC73582 Cylinder Volume: 144.4 CF
 Laboratory: ASG - Chicago - IL Cylinder Pressure: 2015 PSIG
 PGVP Number: B12013 Valve Outlet: 660
 Gas Code: CH4,CO,NO,PPN,BALN Certification Date: Apr 02, 2013

Expiration Date: Apr 02, 2021

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	500.0 PPM	507.1 PPM	G1	+/- 1.0% NIST Traceable	03/26/2013, 04/02/2013
CARBON MONOXIDE	500.0 PPM	498.8 PPM	G1	+/- 0.9% NIST Traceable	03/26/2013
METHANE	500.0 PPM	505.1 PPM	G1	+/- 0.7% NIST Traceable	03/27/2013
NITRIC OXIDE	500.0 PPM	507.1 PPM	G1	+/- 1.0% NIST Traceable	03/26/2013, 04/02/2013
PROPANE	500.0 PPM	502.0 PPM	G1	+/- 1% NIST Traceable	03/27/2013
NITROGEN	Balance				

CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	12062429	CC366885	487.1 PPM CARBON MONOXIDE/NITROGEN	+/- 0.6%	Jun 22, 2018
NTRM/CH4	10060916	CC321243	500.5 PPM METHANE/NITROGEN	+/- 0.6%	Aug 07, 2016
NTRM/NO	12061034	CC359504	500.7 PPM NITRIC OXIDE/NITROGEN	+/- 0.5%	Feb 16, 2018
NO2	124206889130	CC323209	4.824 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Oct 25, 2015
NTRM	10060514	CC281296	495.3 PPM PROPANE/AIR	+/- 0.5%	Feb 19, 2016

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nexus 470 AEP0000428	FTIR	Mar 04, 2013
Nicolet 6700 AHR0801332	FTIR	Feb 27, 2013
Nexus 470 AEP0000428	FTIR	Mar 04, 2013
Nexus 470 AEP0000428	FTIR	Mar 04, 2013
(V-1) VARIAN CP3800 FID	FID	Mar 25, 2013

Triad Data Available Upon Request

Notes:

CERTIFICATE OF ANALYSIS Grade of Product: EPA Protocol

Part Number: E03NI99E15A2059 Reference Number: 54-124280274-3
Cylinder Number: CC71056 Cylinder Volume: 144 Cu.Ft.
Laboratory: ASG - Chicago - IL Cylinder Pressure: 2015 PSIG
PGVP Number: B12011 Valve Outlet: 660
Gas Code: NO2 Analysis Date: Sep 12, 2011

Expiration Date: Sep 12, 2013

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1997)" using the assay procedures listed. Analytical Methodology does not require correction for analytical interferences. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.
Do Not Use This Cylinder below 150 psig.i.e. 1 Mega Paas!

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty
NITROGEN DIOXIDE	150.0 PPM	150.4 PPM	G1	+/- 1% NIST Traceable
NITROGEN	Balance			

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Expiration Date
GMIS/NO2	124083511207	CC208246	245.4PPM NITROGEN DIOXIDE/NITROGEN	Nov 25, 2011

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
(FTIR-2)Nicolet Magna	FTIR	Aug 26, 2011

Triad Data Available Upon Request

Notes:

Approved for Release

CERTIFICATE OF ANALYSIS

Grade of Product: PRIMARY STANDARD

Airgas Specialty Gases

12722 South Wentworth Avenue
Chicago, IL 60628
(773) 785-3000 Fax: (773) 785-1928
www.airgas.com

Part Number:	X02NI99P15AD524	Reference Number:	54-124315088-3
Cylinder Number:	CC48271	Cylinder Volume:	144.4 CF
Laboratory:	ASG - Chicago - IL	Cylinder Pressure:	2015 PSIG
Analysis Date:	May 04, 2012	Valve Outlet:	350

Product directly traceable to NIST ASTM Class 1 weights and/or NIST gas mixture reference materials.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration (Mole %)	Analytical Uncertainty
ETHYLENE	100.0 PPM	99.13 PPM	+/- 1%
NITROGEN	Balance		

Notes:

Approved for Release

AIRGAS**CERTIFICATE OF ANALYSIS**

Airgas Specialty Gases
1075 Cinderella Drive
225.388.0900
www.airgas.com

Cylinder Number: 3G9100379DAL Cylinder Volume: 144.4 CF
Laboratory: ASG Port Allen, LA Cylinder Pressure: 2015 PSIG
Analysis Date: Jul 18, 2012 Valve Outlet: 350

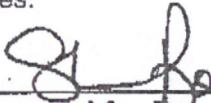
Expiration Date: Jul 18, 2013

Product composition verified by direct comparison to calibration standards traceable to NIST ASTM Class 1 weights and/or NIST gas mixture reference materials.

ANALYTICAL RESULTS

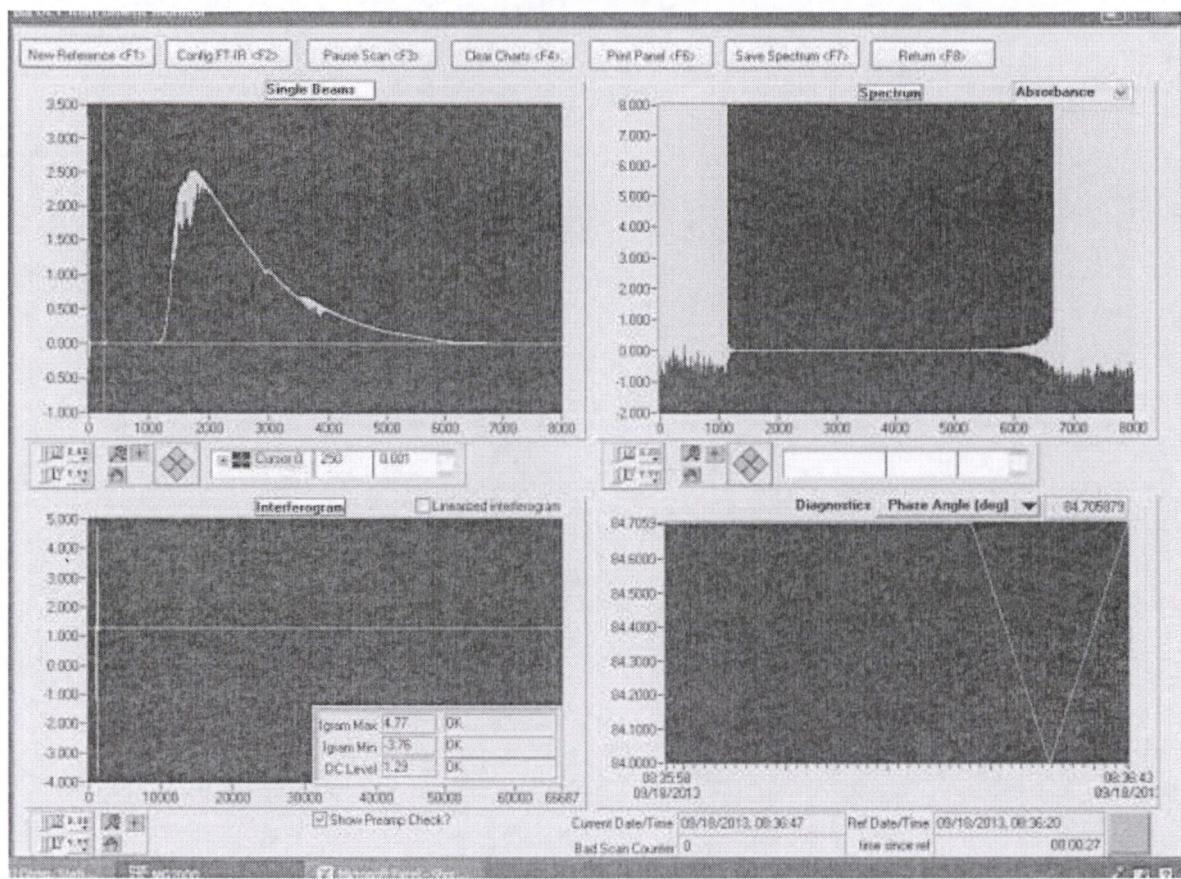
Component	Requested Concentration	Actual Concentration (Mole %)	Analytical Uncertainty
ACETALDEHYDE	30.00 PPM	25.99 PPM	+/- 5%
NITROGEN	Balance		

Notes:


Approved for Release

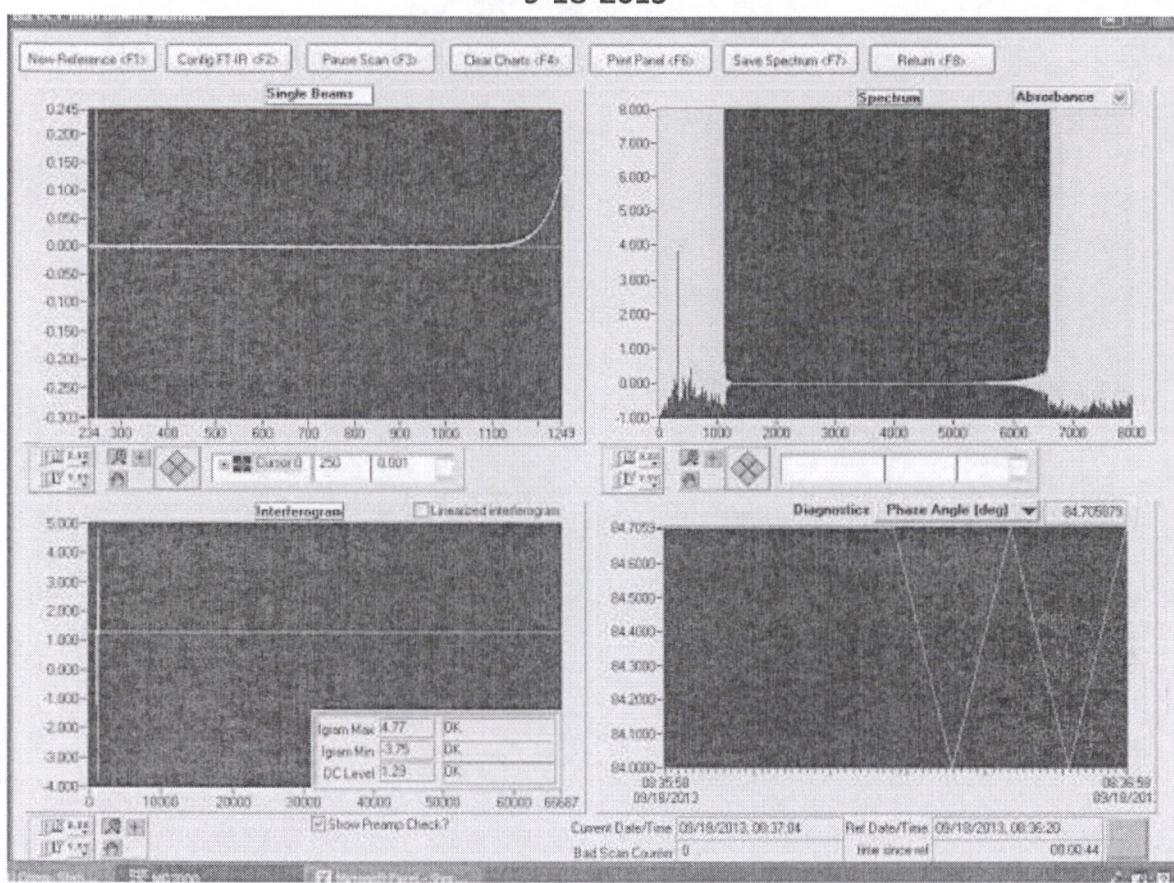
XTO – RBU 11-18F Facility

9-18-2013

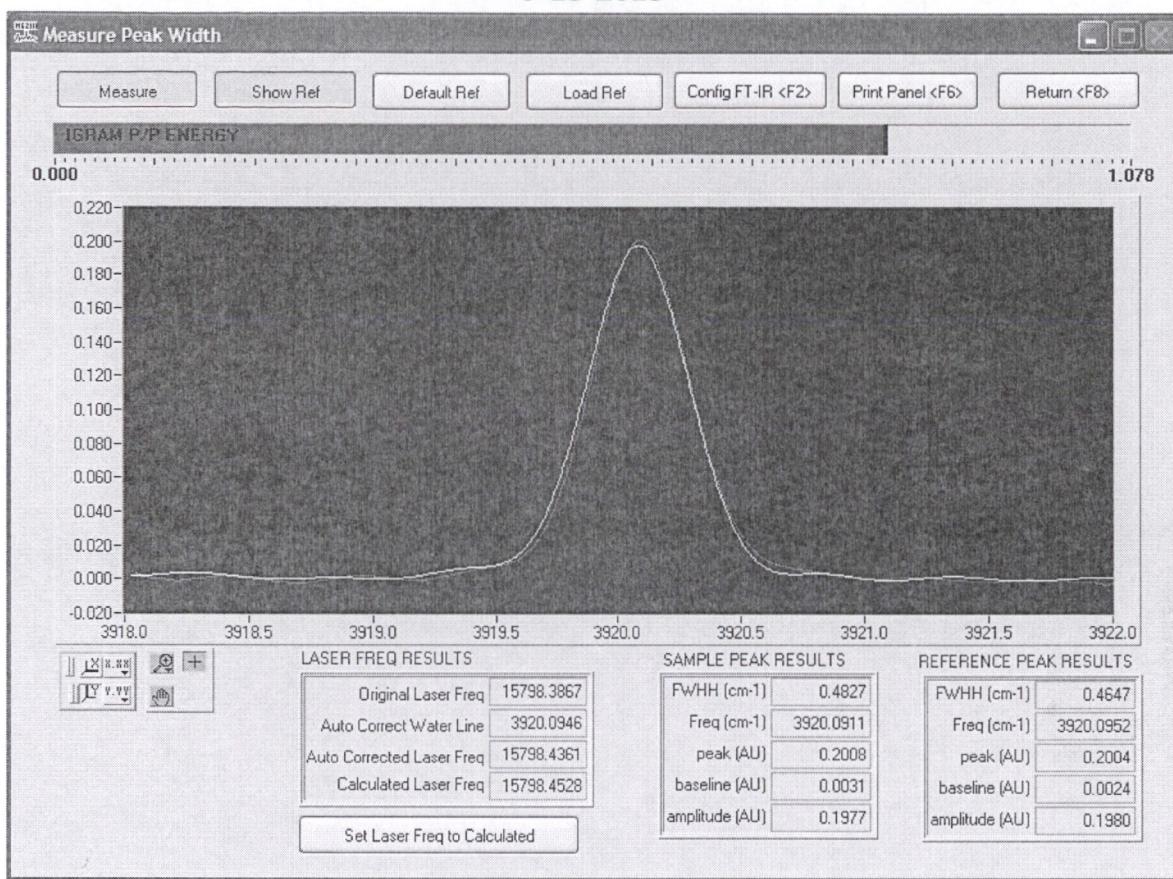


XTO – RBU 11-18F Facility

9-18-2013



XTO – RBU 11-18F Facility
9-18-2013



Instrument Resolution – FWHH – 0.4827 cm⁻¹ which is < 0.55 cm⁻¹ (therefore meets ASTM)

Water Frequency – Freq – 3920.0911 cm⁻¹ which is +/- 0.075 of 3920.0952 cm⁻¹ (therefore meets ASTM)

Please note: FWHH is the Full Width at Half Height of the resolution. The frequency position is only calculating the center line for one water line in the spectrum. MKS uses 3920.0952 cm⁻¹ since it is a single water line.

CO/NO/NO₂/Formaldehyde FTIR Instrument Noise-Limited Minimum Detectable Concentration - MDC#2

Noise Equivalent Absorbance Data				
Spectrum	CO	NO	NO ₂	Formaldehyde
XTO RBU 11-18 F #3 9-18-13_000004.LAB	0.09	-0.24	0.03	-0.03
XTO RBU 11-18 F #3 9-18-13_000005.LAB	0.02	0.01	0.07	-0.03
XTO RBU 11-18 F #3 9-18-13_000006.LAB	-0.02	-0.05	0.05	-0.04
XTO RBU 11-18 F #3 9-18-13_000007.LAB	0.06	-0.05	0.03	0.03
XTO RBU 11-18 F #3 9-18-13_000008.LAB	-0.14	-0.09	-0.05	0.00
XTO RBU 11-18 F #3 9-18-13_000009.LAB	0.06	-0.07	0.05	-0.05
XTO RBU 11-18 F #3 9-18-13_000010.LAB	0.01	-0.22	-0.01	0.06
XTO RBU 11-18 F #3 9-18-13_000011.LAB	-0.24	-0.03	0.10	-0.02
XTO RBU 11-18 F #3 9-18-13_000012.LAB	-0.25	-0.04	-0.01	-0.03
XTO RBU 11-18 F #3 9-18-13_000013.LAB	-0.07	-0.03	0.01	0.08
Noise Equivalent Absorbance (Standard Deviation)	0.12	0.08	0.04	0.04
MDC #2	0.35	0.24	0.12	0.13

APPENDIX C

G3516

GAS COMPRESSION APPLICATION

GAS ENGINE SITE SPECIFIC TECHNICAL DATA XTO - RBU 11-18F #3

CATERPILLAR®

ENGINE SPEED (rpm):	1360	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	8:1	FUEL SYSTEM:	HPG IMPCO
AFTERTCOOLER TYPE:	SCAC	SITE CONDITIONS:	WITH AIR FUEL RATIO CONTROL
AFTERCooler WATER INLET (°F):	130	FUEL:	Field Gas
JACKET WATER OUTLET (°F):	210	FUEL PRESSURE RANGE(psig):	35.0-40.0
ASPIRATION:	TA	FUEL METHANE NUMBER:	62.2
COOLING SYSTEM:	JW+OC, AC	FUEL LHV (Btu/scf):	1027
CONTROL SYSTEM:	ADEM3	ALTITUDE(ft):	5278
EXHAUST MANIFOLD:	ASWC	MAXIMUM INLET AIR TEMPERATURE(°F):	84
COMBUSTION:	Low Emission	STANDARD RATED POWER:	1340 bhp@1400rpm
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0		
SET POINT TIMING:	27		

RATING	NOTES	LOAD	100%	100%	75%	57%
ENGINE POWER (WITHOUT FAN)	(1)	bhp °F	1301 42	1169 84	877 84	670 84
INLET AIR TEMPERATURE						

ENGINE DATA						
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	7701	7793	8086	8418
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	8510	8611	8935	9302
AIR FLOW (@inlet air temp, 14.7 psia)	(WET)	ft3/min	2587	2522	1910	1491
AIR FLOW	(WET)	lb/hr	12271	11039	8361	6524
FUEL FLOW (60°F, 14.7 psia)	(3)(4)	scfm	163	148	115	91
INLET MANIFOLD PRESSURE	(3)(4)	in Hg(abs)	69.0	63.0	49.6	39.6
EXHAUST TEMPERATURE - ENGINE OUTLET	(5)	°F	907	907	907	910
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(6)	ft3/min	7618	6856	5204	4073
EXHAUST GAS MASS FLOW	(WET)	lb/hr	12753	11478	8702	6796

EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)	(8)(9)	g/bhp-hr	2.00	2.00	2.00	2.00
CO	(8)(9)	g/bhp-hr	2.26	2.30	2.41	2.52
THC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	2.43	2.47	2.57	2.68
NMHC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.63	0.64	0.67	0.70
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)(10)	g/bhp-hr	0.42	0.43	0.45	0.47
HCHO (Formaldehyde)	(8)(9)	g/bhp-hr	0.22	0.22	0.22	0.24
CO2	(8)(9)	g/bhp-hr	507	511	522	540
EXHAUST OXYGEN	(8)(11)	% DRY	7.8	7.8	7.7	7.5

HEAT REJECTION						
HEAT REJ. TO JACKET WATER (JW)	(12)	Btu/min	42577	39978	34050	29366
HEAT REJ. TO ATMOSPHERE	(12)	Btu/min	5161	4811	4039	3492
HEAT REJ. TO LUBE OIL (OC)	(12)	Btu/min	6350	5962	5078	4380
HEAT REJ. TO AFTERTCOOLER (AC)	(12)(13)	Btu/min	10703	10703	5168	2444

COOLING SYSTEM SIZING CRITERIA			
TOTAL JACKET WATER CIRCUIT (JW+OC)	(13)	Btu/min	54455
TOTAL AFTERTCOOLER CIRCUIT (AC)	(13)(14)	Btu/min	11238

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Max. rating is the maximum capability for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 1 - intake man press -> 20 psi -> 40.72 in Hg

$$\text{Patm} = 24.71 \text{ in Hg}$$

$$\text{Pabs} = 65.43 \text{ in Hg}$$

by linear interpolation, est BHP => 1222.5 BHP

G3516

GAS COMPRESSION APPLICATION

GAS ENGINE SITE SPECIFIC TECHNICAL DATA XTO - RBU 11-18F #3

CATERPILLAR®

ENGINE SPEED (rpm):	1362	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	8:1	FUEL SYSTEM:	HPG IMPCO
AFTERCooler TYPE:	SCAC	SITE CONDITIONS:	WITH AIR FUEL RATIO CONTROL
AFTERCOOLER WATER INLET (°F):	130	FUEL:	Field Gas
JACKET WATER OUTLET (°F):	210	FUEL PRESSURE RANGE(psig):	35.0-40.0
ASPIRATION:	TA	FUEL METHANE NUMBER:	62.2
COOLING SYSTEM:	JW+OC, AC	FUEL LHV (Btu/scf):	1027
CONTROL SYSTEM:	ADEM3	ALTITUDE(ft):	5278
EXHAUST MANIFOLD:	ASWC	MAXIMUM INLET AIR TEMPERATURE(°F):	86
COMBUSTION:	Low Emission	STANDARD RATED POWER:	1340 bhp@1400rpm
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0		
SET POINT TIMING:	27		

RATING	NOTES	LOAD	100%	100%	75%	57%
ENGINE POWER (WITHOUT FAN)	(1)	bhp °F	1303 42	1165 86	874 86	670 86

ENGINE DATA						
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	7702	7798	8094	8423
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	8511	8617	8944	9307
AIR FLOW (@inlet air temp, 14.7 psia)	(WET)	(3)(4)	2591	2524	1913	1497
AIR FLOW	(WET)	(3)(4)	lb/hr	12292	11009	8341
FUEL FLOW (60°F, 14.7 psia)			scfm	163	147	115
INLET MANIFOLD PRESSURE			in Hg(abs)	69.1	62.8	49.4
EXHAUST TEMPERATURE - ENGINE OUTLET			°F	907	907	910
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(7)(4)	ft3/min	7632	6838	5192
EXHAUST GAS MASS FLOW	(WET)	(7)(4)	lb/hr	12776	11447	8682

EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)	(8)(9)	g/bhp-hr	2.00	2.00	2.00	2.00
CO	(8)(9)	g/bhp-hr	2.26	2.30	2.41	2.52
THC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	2.43	2.47	2.58	2.68
NMHC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.63	0.64	0.67	0.70
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)(10)	g/bhp-hr	0.42	0.43	0.45	0.47
HCHO (Formaldehyde)	(8)(9)	g/bhp-hr	0.22	0.22	0.22	0.24
CO2	(8)(9)	g/bhp-hr	508	511	523	541
EXHAUST OXYGEN	(8)(11)	% DRY	7.8	7.8	7.7	7.5

HEAT REJECTION						
HEAT REJ. TO JACKET WATER (JW)	(12)	Btu/min	42630	39914	34033	29391
HEAT REJ. TO ATMOSPHERE	(12)	Btu/min	5169	4804	4034	3495
HEAT REJ. TO LUBE OIL (OC)	(12)	Btu/min	6358	5953	5076	4383
HEAT REJ. TO AFTERCOOLER (AC)	(12)(13)	Btu/min	10885	10885	5201	2482

COOLING SYSTEM SIZING CRITERIA						
TOTAL JACKET WATER CIRCUIT (JW+OC)	(13)	Btu/min	54522			
TOTAL AFTERCOOLER CIRCUIT (AC)	(13)(14)	Btu/min	11429			

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Max. rating is the maximum capability for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 2 - intake man press -> 20 psi -> 40.72 in Hg

$$P_{atm} = 24.70 \text{ in Hg}$$

$$P_{abs} = 65.42 \text{ in Hg}$$

by linear interpolation, est BHP => 1222.4 BHP

G3516

GAS COMPRESSION APPLICATION

GAS ENGINE SITE SPECIFIC TECHNICAL DATA XTO - RBU 11-18F #3

CATERPILLAR®

ENGINE SPEED (rpm):	1362	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	8:1	FUEL SYSTEM:	HPG IMPCO
AFTERTCOOLER TYPE:	SCAC		WITH AIR FUEL RATIO CONTROL
AFTERCOOLER WATER INLET (°F):	130		
JACKET WATER OUTLET (°F):	210		
ASPIRATION:	TA		Field Gas
COOLING SYSTEM:	JW+OC, AC		35.0-40.0
CONTROL SYSTEM:	ADEM3		62.2
EXHAUST MANIFOLD:	ASWC		1027
COMBUSTION:	Low Emission		5278
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0	MAXIMUM INLET AIR TEMPERATURE(°F):	86
SET POINT TIMING:	27	STANDARD RATED POWER:	1340 bhp@1400rpm

RATING	NOTES	LOAD	100%	100%	75%	57%
ENGINE POWER INLET AIR TEMPERATURE	(WITHOUT FAN)	(1) bhp °F	1303 42	1165 86	874 86	670 86

ENGINE DATA						
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	7702	7798	8094	8423
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	8511	8617	8944	9307
AIR FLOW (@inlet air temp, 14.7 psia)	(WET) (3)(4)	ft3/min	2591	2524	1913	1497
AIR FLOW	(WET) (3)(4)	lb/hr	12292	11009	8341	6528
FUEL FLOW (60°F, 14.7 psia)		scfm	163	147	115	92
INLET MANIFOLD PRESSURE	(5)	in Hg(abs)	69.1	62.8	49.4	39.6
EXHAUST TEMPERATURE - ENGINE OUTLET	(6)	°F	907	907	907	910
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET) (7)(4)	ft3/min	7632	6838	5192	4075
EXHAUST GAS MASS FLOW	(WET) (7)(4)	lb/hr	12776	11447	8682	6800

EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)	(8)(9)	g/bhp-hr	2.00	2.00	2.00	2.00
CO	(8)(9)	g/bhp-hr	2.26	2.30	2.41	2.52
THC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	2.43	2.47	2.58	2.68
NMHC (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.63	0.64	0.67	0.70
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)(10)	g/bhp-hr	0.42	0.43	0.45	0.47
HCHO (Formaldehyde)	(8)(9)	g/bhp-hr	0.22	0.22	0.22	0.24
CO2	(8)(9)	g/bhp-hr	508	511	523	541
EXHAUST OXYGEN	(8)(11)	% DRY	7.8	7.8	7.7	7.5

HEAT REJECTION						
HEAT REJ. TO JACKET WATER (JW)	(12)	Btu/min	42630	39914	34033	29391
HEAT REJ. TO ATMOSPHERE	(12)	Btu/min	5169	4804	4034	3495
HEAT REJ. TO LUBE OIL (OC)	(12)	Btu/min	6358	5953	5076	4383
HEAT REJ. TO AFTERTCOOLER (AC)	(12)(13)	Btu/min	10885	10885	5201	2482

COOLING SYSTEM SIZING CRITERIA			
TOTAL JACKET WATER CIRCUIT (JW+OC)	(13)	Btu/min	54522
TOTAL AFTERTCOOLER CIRCUIT (AC)	(13)(14)	Btu/min	11429

A cooling system safety factor of 0% has been added to the cooling system sizing criteria.

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Max. rating is the maximum capability for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Run 3 - intake man press -> 20 psi -> 40.72 in Hg

$$\text{Patm} = 24.70 \text{ in Hg}$$

$$\text{Pabs} = 65.42 \text{ in Hg}$$

by linear interpolation, est BHP => 1222.4 BHP

APPENDIX D

EPA Method 19 Calculations

Test Run	Fd Factor	BSFC	BHP	Avg O2 %	NOx PPM Corrected	CO PPM Corrected	NOx lbs/hr	CO lbs/hr	NOx gr/BHP-hr	CO gr/BHP-hr
1	8710	9400	1222.5	8.3	199.8	65.0	3.95	0.78	1.47	0.29
2	8710	9400	1222.4	8.4	200.4	65.0	3.99	0.79	1.48	0.29
3	8710	9400	1222.4	8.3	184.8	64.8	3.65	0.78	1.36	0.29
Average Levels			1222.4	8.3	195.0	64.9	3.86	0.79	1.43	0.29

APPENDIX E

FTIR Engine Test Sheet

Company Name	XTO
Location / Unit I.D.	RBU 11-18 F #3
Type of Test Completed:	FTIR - CO, NOx, Lcoh @ 15% o2 3-lhr
Field Technician (s)	JEFF
Client Rep and/or State Rep	Derrick - XTO
Date:	9-18-13

	Test 1	Test 2	Test 3
Time of Readings	2:36 pm	4:13 pm	5:05 pm
Atm Pressure (in Hg)	24.71	24.70	24.70
Atm Temp (°F)	84°	86°	86°
Engine RPM	1360	1362	1362
*Manifold Pres. Vac ^c or Boost(psi)	20	20	20
Manifold Temp (°F)			
Psuction (psi) Stage 1	34	34	34
Tsuction (°F) Stage 1	82°	83°	84°
Pdischarge (psi) Stage 1	124	126	125
Psuction (psi) Stage 2	124	126	125
Tsuction (°F) Stage 2	92°	92°	93°
Pdischarge (psi) Stage 2	359	360	361
Psuction (psi) Stage 3	359	360	361
Tsuction (°F) Stage 3	98°	99°	99°
Pdischarge (psi) Stage 3	1023	1022	1024
Psuction (psi) Stage 4			
Tsuction (°F) Stage 4			
Pdischarge (psi) Stage 4			
Gas Throughput (mmcf/d)			
Pre CO (ppm)			
Pre Cat Temp (°F)	846°	843°	844°
Post Cat Temp (°F)	807°	809°	810°
Cat Differential Pres. (* of H2O)	6.1	6.1	6.1
Impinger 1 (grams)	/	/	/
Impinger 2 (grams)	/	/	/
Impinger 3 (grams)	/	/	/
Impinger 4 (grams)	/	/	/
Dry Gas Meter (cubic ft)	/	/	/
DGM Inlet Temp (deg F)	/	/	/
DGM Outlet Temp (deg F)	/	/	/
O2 %	8.3	8.4	8.3
CO2 %	7.5	7.5	7.5
LOAD %			
Delta H			
Ignition Timing (°F)			
AFR Setting mV (Left Bank)			
AFR Setting mV (Right Bank)			
Upstream Port Distance (pd)			
Downstream Port Distance (pd)			
Exhaust Diameter (inches)			Cylinder Serial #↓
Propane	507		
NO	507		
CO	498.8		
NO2	150		
Ethylene	99		
Methane	505		
Acetaldehyde	25.99		
Engine Make	CAT		
Engine Model	3516		
Engine S/N	4EKO4571	No Tag	

* Some units show boost in inches of Hg. In this situation please indicate if it is positive (+) or negative (-). Eg: (+12") or (-5")

SN from Mechanic
4EKO4571 No tag on Engine

Rev 5

5/25/2011